



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
25.11.2020 Bulletin 2020/48

(51) Int Cl.:
H02M 1/08 (2006.01) H02M 3/00 (2006.01)

(21) Application number: **18900691.9**

(86) International application number:
PCT/JP2018/000976

(22) Date of filing: **16.01.2018**

(87) International publication number:
WO 2019/142235 (25.07.2019 Gazette 2019/30)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD TN

(71) Applicant: **Shindengen Electric Manufacturing Co., Ltd.**
Tokyo 100-0004 (JP)

(72) Inventors:
• **YAMAZAKI, Masashi**
Hanno-shi, Saitama 357-8585 (JP)
• **KURADATE, Takuya**
Hanno-shi, Saitama 357-8585 (JP)

(74) Representative: **AWA Sweden AB**
Junkersgatan 1
582 35 Linköping (SE)

(54) **VEHICLE POWER SUPPLY CONTROL CIRCUIT, VEHICLE CONTROL DEVICE, AND VEHICLE POWER SUPPLY CONTROL CIRCUIT CONTROL METHOD**

(57) A power supply control circuit for a vehicle includes: a first input terminal to which a voltage output from a DC-DC converter converting a power supply voltage is supplied; a second input terminal to which the power supply voltage is supplied; an output terminal to output a voltage for controlling semiconductor elements that generate a drive current for a motor generator and have unsaturated region characteristics; a switch circuit having one end connected to the first input terminal and the other end connected to the output terminal, the switch

circuit is turned on based on a signal applied to the control terminal to establish electrical connection between the first input terminal and the output terminal, on the other hand, the switch circuit is turned off based on a signal applied to the control terminal to cuts off between the first input terminal and the output terminal; and a switch controller that controls the switch circuit by applying a signal to the control terminal based on the voltage of the second input terminal.

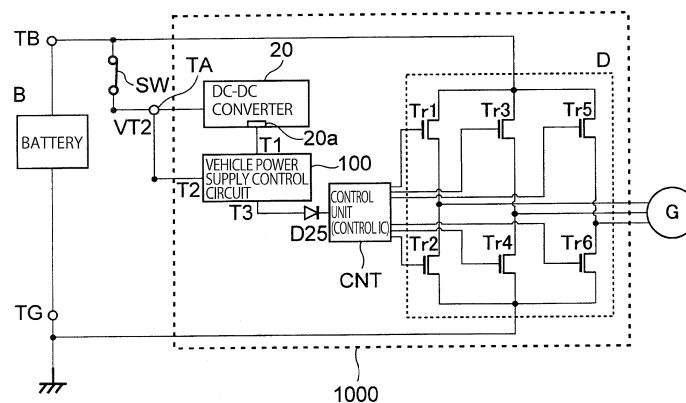


FIG. 1

Description

[Technical Field]

[0001] The present invention relates to a vehicle power supply control circuit, a vehicle control device, and a vehicle power supply control circuit control method.

[Background Art]

[0002] Conventionally, for example, in a motorcycle, when a user turns off a main switch to stop an engine, a power supply voltage supplied from a battery and an ACG (a motor generator) is lowered to stop the system. When the battery is open while the system is stopped in this way, the power supply voltage drops faster.

[0003] In such a conventional system, a capacitor is connected to the output of the DC-DC converter built in the ECU. Then, after the supply of the power supply voltage to the DC-DC converter is cut off, the output voltage output from the DC-DC converter is held for some time.

[0004] Then, until the output voltage of the DC-DC converter is stopped, this output voltage is applied to the gate of the FET that constitutes the driver circuit that controls the ACG, and there is a concern that the FET may operate in the unsaturated region.

[0005] Here, for example, Patent Document 1 discloses a semiconductor switch circuit that cuts off a load current. However, the semiconductor switch circuit does not prevent the unsaturated operation of the semiconductor element (MOSFET) that generates the ACG drive current and has the unsaturated region characteristic, based on the power supply voltage.

[Prior Art Documents]

[Patent Literature]

[0006] [Patent Document 1] JP1990-202117

[Disclosure of the Invention]

[Problem to be Solved by the Invention]

[0007] Therefore, an object of the present invention is to provide a vehicle power supply control circuit capable of preventing unsaturated operation of a semiconductor element, by controlling conduction / interruption between an output of a DC-DC converter, for converting the power supply voltage into a voltage, and the output terminal, for generating a driving current of ACG and outputting a voltage for driving a semiconductor element having an unsaturated region characteristic, based on the power supply voltage.

[Solution to Problem]

[0008] A vehicle power supply control circuit according

to an embodiment according to an aspect of the present invention includes:

a first input terminal to which a voltage output from an DC-DC converter converting a power supply voltage is supplied;

a second input terminal to which the power supply voltage is supplied;

an output terminal to output a voltage for controlling semiconductor elements generating a drive current for a motor generator and having unsaturated region characteristics;

a switch circuit having one end connected to the first input terminal and the other end connected to the output terminal, the switch circuit is turned on based on a signal applied to a control terminal thereof to establish electrical connection between the first input terminal and the output terminal, on the other hand, the switch circuit is turned off based on a signal applied to the control terminal to cut off between the first input terminal and the output terminal; and

a switch controller that controls the switch circuit by applying a signal to the control terminal based on the voltage of the second input terminal,

wherein

the switch controller turns on the switch circuit, when the power supply voltage supplied to the second input terminal rises and becomes equal to or higher than a preset first threshold voltage while the switch circuit is off, and

after that, after the power supply voltage further rise, the switch controller turns off the switch circuit, when the power supply voltage supplied to the second input terminal becomes less than a second threshold voltage different from the first threshold voltage.

[0009] In the vehicle power supply control circuit, wherein the semiconductor element is a MOSFET, and the voltage for controlling the semiconductor element is a gate voltage of the MOSFET.

[0010] In the vehicle power supply control circuit, wherein the switch controller comprises:

a first control circuit that operates to turn on the switch circuit when the power supply voltage becomes equal to or higher than the first threshold voltage, and the first control circuit operates to turn off the switch circuit when the power supply voltage becomes lower than the first threshold voltage;

a second control circuit that operates to turn on the switch circuit when the power supply voltage becomes equal to or higher than the second threshold voltage, and the second control circuit operates to turn off the switch circuit when the power supply voltage becomes lower than the second threshold voltage;

a third control circuit that controls the operation of the first control circuit based on the power supply

voltage supplied to the second input terminal, wherein the third control circuit controls the first control circuit to prevents the switch circuit from being turned on by the first control circuit, when the power supply voltage is equal to or higher than a preset third threshold voltage which is higher than the second threshold voltage.

[0011] In the vehicle power supply control circuit, wherein the first control circuit includes:

a first bipolar transistor being a first conductivity type bipolar transistor, having a collector connected to the control terminal, and having an emitter connected to a fixed potential;
a first resistor having one end connected to the second input terminal;
a first diode having an anode connected to the first resistor, and having a cathode connected to a base of the first bipolar transistor; and
a second resistor having one end connected to a base of the first bipolar transistor, and having the other end connected to the fixed potential.

[0012] In the vehicle power supply control circuit, wherein the second control circuit includes:

a second bipolar transistor being a first conductivity type bipolar transistor, having a collector connected to the control terminal, and having an emitter is connected to the fixed potential;
a first Zener diode having a cathode connected to the second input terminal;
a third resistor having one end connected to the anode of the first Zener diode, and having the other end connected to a base of the second bipolar transistor; and
a fourth resistor having one end connected to the base of the second bipolar transistor, and having the other end connected to the emitter of the second bipolar transistor.

[0013] In the vehicle power supply control circuit, wherein the third control circuit includes:

a second Zener diode having a cathode connected to the second input terminal;
a fifth resistor having one end connected to an anode of the second Zener diode;
a sixth resistor having one end connected to the other end of the fifth resistor, and having the other end connected to the fixed potential;
a third bipolar transistor being a first conductivity type bipolar transistor, having an emitter connected to the other end of the sixth resistor, and having a base connected to one end of the sixth resistor;
a fourth bipolar transistor being a second conductivity type bipolar transistor having an emitter connect-

ed to the anode of the first diode, having a collector connected to the base of the third bipolar transistor, and having a base connected to a collector of the third bipolar transistor; and

a capacitor having one end connected to the emitter of the fourth bipolar transistor, and having the other end connected to the emitter of the third bipolar transistor.

[0014] In the vehicle power supply control circuit, wherein the switch circuit includes:

a switch bipolar transistor having an emitter connected to the first input terminal, and having a collector connected to the output terminal;
a first switch resistor having one end connected to a base of the switch bipolar transistor, and having the other end connected to the control terminal; and
a second switch resistor having one end connected to the emitter of the switch bipolar transistor, and having the other end connected to the base of the switch bipolar transistor.

[0015] In the vehicle power supply control circuit, wherein,

when the power supply voltage initially rises, the switch controller turns on the switch bipolar transistor by the first control circuit to establish conduction between the first input terminal and the output terminal, by turning on the first bipolar transistor by passing a base current through a path from the first resistor to the first diode, then, when the power supply voltage further rises, the switch controller turns on the switch bipolar transistor by the second control circuit, by turning on the second bipolar transistor by passing a base current through a path from the first Zener diode to the third resistor, and then, when the power supply voltage further rises, the switch controller turns off the switch bipolar transistor, by turning on the third bipolar transistor and the fourth bipolar transistor by passing a base current through a path from the second Zener diode to the fifth resistor.

[0016] In the vehicle power supply control circuit, wherein, when the power supply voltage drops below the second threshold voltage from the state in which the second to fourth bipolar transistors are turned on after turning off the first bipolar transistor, the switch controller turns off the switch bipolar transistor by the second control circuit, by turning off the second bipolar transistor, to disconnect between the first input terminal and the output terminal.

[0017] In the vehicle power supply control circuit, wherein the voltage output from the output terminal is supplied to a control unit that drives the semiconductor element via a diode.

[0018] In the vehicle power supply control circuit, further comprising a protection resistor having one end connected to the output terminal and the other end connected to a fixed potential.

[0019] In the vehicle power supply control circuit, wherein the first input terminal is electrically connected to an output of the DC-DC converter, wherein the second input terminal is electrically connected to an input of the DC-DC converter, and wherein the DC-DC converter includes a smoothing capacitor connected to the output of the DC-DC converter.

[0020] In the vehicle power supply control circuit, wherein the vehicle power supply control circuit is mounted on a motorcycle, wherein the MOSFET constitutes a driver circuit of the motor generator connected to an internal combustion engine of the motorcycle, wherein the control IC drives the internal combustion engine by driving the motor generator with the driver circuit based on a voltage output from the vehicle power supply control circuit, and wherein a battery mounted on the motorcycle is connected between the power supply terminal to which the power supply voltage is applied and the fixed potential.

[0021] In the vehicle power supply control circuit, wherein the supply of the power supply voltage is controlled by a main switch of the two-wheeled vehicle operated by a user.

[0022] In the vehicle power supply control circuit, wherein a threshold value of the first bipolar transistor is set to turn on the first bipolar transistor, when the power supply voltage initially rises, by passing the base current through the path from the first resistor to the first diode, wherein a threshold value of the second bipolar transistor is set to turn on the second bipolar transistor, by passing the base current from the first Zener diode through the path of the third resistor, if the power supply voltage rises further than a voltage when the power supply voltage initially rises, and wherein a threshold value of the switch bipolar transistor is set to turn on the switch bipolar transistor, when the first bipolar transistor is turned on or the second bipolar transistor is turned on.

[0023] A vehicle control device according to an embodiment according to an aspect of the present invention, includes:

- a DC-DC converter that converts a power supply voltage into a voltage;
- a vehicle power supply control circuit to which the voltage output from the DC-DC converter is supplied;
- a driver circuit that includes a semiconductor element, the semiconductor element generating a drive current for a motor generator and having unsaturated region characteristics, and
- a control unit that controls the driver circuit based on a voltage output from the vehicle power supply control circuit,

wherein the vehicle power supply control circuit comprises:

- a first input terminal to which a voltage output

- from the DC-DC converter is supplied;
- a second input terminal to which the power supply voltage is supplied;
- an output terminal to output a voltage for controlling semiconductor elements generating a drive current for a motor generator and having unsaturated region characteristics;
- a switch circuit having one end connected to the first input terminal and the other end connected to the output terminal, the switch circuit is turned on based on a signal applied to a control terminal thereof to establish electrical connection between the first input terminal and the output terminal, on the other hand, the switch circuit is turned off based on a signal applied to the control terminal to cuts off between the first input terminal and the output terminal; and
- a switch controller that controls the switch circuit by applying a signal to the control terminal based on the voltage of the second input terminal, wherein the switch controller turns on the switch circuit, when the power supply voltage supplied to the second input terminal rises and becomes equal to or higher than a preset first threshold voltage while the switch circuit is off, and after that, after the power supply voltage further rise, the switch controller turns off the switch circuit, when the power supply voltage supplied to the second input terminal becomes less than a second threshold voltage different from the first threshold voltage.

[0024] A vehicle power supply control circuit control method of vehicle power supply control circuit according to an embodiment according to an aspect of the present invention, the vehicle power supply control circuit comprising: a first input terminal to which a voltage output from an DC-DC converter converting a power supply voltage is supplied; a second input terminal to which the power supply voltage is supplied; an output terminal to output a voltage for controlling semiconductor elements generating a drive current for a motor generator and having unsaturated region characteristics; a switch circuit having one end connected to the first input terminal and the other end connected to the output terminal, the switch circuit is turned on based on a signal applied to a control terminal thereof to establish electrical connection between the first input terminal and the output terminal, on the other hand, the switch circuit is turned off based on a signal applied to the control terminal to cuts off between the first input terminal and the output terminal; and a switch controller that controls the switch circuit by applying a signal to the control terminal based on the voltage of the second input terminal, wherein the switch controller turns on the switch circuit, when the power supply voltage supplied to the second input terminal

nal rises and becomes equal to or higher than a preset first threshold voltage while the switch circuit is off, and after that, after the power supply voltage further rise, the switch controller turns off the switch circuit, when the power supply voltage supplied to the second input terminal becomes less than a second threshold voltage different from the first threshold voltage.

[Effects of the Invention]

[0025] A vehicle power supply control circuit according to an embodiment according to an aspect of the present invention includes: a first input terminal to which a voltage output from a DC-DC converter converting a power supply voltage is supplied; a second input terminal to which the power supply voltage is supplied; an output terminal to output a voltage for controlling semiconductor elements generating a drive current for a motor generator and having unsaturated region characteristics; a switch circuit having one end connected to the first input terminal and the other end connected to the output terminal, the switch circuit is turned on based on a signal applied to a control terminal thereof to establish electrical connection between the first input terminal and the output terminal, on the other hand, the switch circuit is turned off based on a signal applied to the control terminal to cuts off between the first input terminal and the output terminal; and a switch controller that controls the switch circuit by applying a signal to the control terminal based on the voltage of the second input terminal.

[0026] The switch controller turns on the switch circuit, when the power supply voltage supplied to the second input terminal rises and becomes equal to or higher than a preset first threshold voltage while the switch circuit is off, and after that, after the power supply voltage further rise, the switch controller turns off the switch circuit, when the power supply voltage supplied to the second input terminal becomes less than a second threshold voltage different from the first threshold voltage.

[0027] That is, according to the vehicle power supply control circuit of the present invention, the unsaturated operation of the semiconductor element can be prevented by controlling conduction/interruption between the output of the DC-DC converter for converting the power supply voltage into a voltage and the output terminal for outputting a voltage for driving the semiconductor element that generates drive current for the ACG and has unsaturated region characteristics, based on the power supply voltage.

[Brief Description of the Drawings]

[0028]

[FIG. 1] FIG. 1 is a diagram showing an example of a configuration of a vehicle control device 1000 according to an embodiment of the present invention.
[FIG. 2] FIG. 2 is a diagram showing an example of

a configuration of a vehicle power supply control circuit 100 shown in FIG.1.

[FIG. 3] FIG. 3 is a diagram showing an example of input / output waveforms of the vehicle power supply control circuit 100 shown in FIG. 2.

[Embodiments for Carrying Out the Invention]

[0029] Embodiments of the present invention will now be described with reference to the accompanying drawings.

[First Embodiment]

[0030] FIG. 1 is a diagram showing an example of a configuration of a vehicle control device 1000 according to an embodiment of the present invention. FIG. 2 is a diagram showing an example of a configuration of a vehicle power supply control circuit 100 shown in FIG.1. FIG. 3 is a diagram showing an example of input / output waveforms of the vehicle power supply control circuit 100 shown in FIG. 2.

[0031] For example, a system including a vehicle control device 1000, a main switch SW, a battery B, and a motor generator G shown in FIG. 1 is mounted on a motorcycle.

[0032] The motor generator G is connected to, for example, an internal combustion engine (not shown in the Figure) of the two-wheeled vehicle, furthermore drives the internal combustion engine, and rotates by the internal combustion engine to generate electric power.

[0033] A battery B is connected between the power supply terminal TB and the ground terminal (that is, the ground potential which is a fixed potential) TG.

[0034] This battery B is removable from the power supply terminal TB and the ground terminal TG. For example, when the positive electrode of the battery B is removed from the power supply terminal TB, the battery B becomes open.

[0035] Also, the main switch SW is connected between the power supply terminal TB to which the power supply voltage VT2 is applied and the connection terminal TA.

[0036] The main switch SW is controlled to be turned on / off by a user operation. The connection terminal TA is connected to the second input terminal T2.

[0037] Then, the supply of the power supply voltage VT2 of the power supply terminal TB to the vehicle control device (ECU) 1000 is controlled by the main switch SW of the motorcycle operated by the user.

[0038] That is, when the user turns on the main switch SW, the power supply voltage VT2 is supplied from the battery B or the motor generator G (driver circuit D) to the DC-DC converter 20 and the vehicle power supply control circuit 100.

[0039] On the other hand, when the user turns off the main switch SW, the supply of the power supply voltage VT2 to the DC-DC converter 20 and the vehicle power supply control circuit 100 is cut off.

[0040] Here, the vehicle control device (ECU) 1000 according to the embodiment, for example, as shown in FIG. 1, comprises the DC-DC converter 20, the vehicle power supply control circuit 100, the diode D25, and the control unit (control IC) CNT and a driver circuit D.

[0041] The DC-DC converter 20 converts (for example, boosting or stepping up / down) the power supply voltage VT2 supplied from the battery B or the motor generator G (the driver circuit D) through the main switch SW and the connection terminal TA.

[0042] The DC-DC converter 20 includes a smoothing capacitor 20a connected to the output of the DC-DC converter 20. According to the time constant of the smoothing capacitor 20a, the output of the DC-DC converter 20 decreases after the power supply voltage VT2 decreases (the output is held for a predetermined time (FIG. 3)).

[0043] In the diode D25, for example, as shown in FIGS. 1 and 2, the anode of the diode D25 is connected to the output terminal T3 and the cathode of the diode D25 is connected to the input of the control unit CNT.

[0044] This diode D25 rectifies the voltage VT3 output from the vehicle power supply control circuit 100 and outputs the rectified voltage to the control unit CNT.

[0045] Further, the driver circuit D includes, for example, as shown in FIG. 1, a plurality of (six in the example of FIG. 1) semiconductor elements Tr1 to Tr6 forming a three-phase bridge circuit. The semiconductor elements Tr1 to Tr6 are MOSFETs, and the voltage for controlling the semiconductor elements Tr1 to Tr6 is the gate voltage of the MOSFETs.

[0046] That is, the semiconductor elements Tr1 to Tr6, which are MOSFETs, constitute the driver circuit D of the motor generator G connected to the internal combustion engine of the motorcycle described above.

[0047] Then, for example, as shown in FIG. 1, in the driver circuit D, when the motor generator G is driven, the first to sixth MOSFETs Tr1 to Tr6 operate according to the gate control signal output from the control unit CNT. As a result, the driver circuit D supplies the motor generator G with the three-phase AC voltage obtained by converting the DC voltage between the power supply terminal TB and the ground terminal TG to drive the motor generator G.

[0048] On the other hand, in the driver circuit D, during regeneration by the motor generator G, the first to sixth MOSFETs Tr1 to Tr6 operates according to the gate control signal output from the control unit CNT. As a result, the driver circuit D converts the counter electromotive voltage output from the motor generator G into a DC regenerative voltage, and the driver circuit D supplies the DC regenerative voltage to between the power supply terminal TB and the ground terminal TG.

[0049] Also, the control unit (the control IC) CNT is configured to operate by the power supplied from the battery B or the motor generator G, via the DC-DC converter 20, the vehicle power supply control circuit 100, and the diode D25, in the configuration shown in the example of FIG. 1.

[0050] Here, the control unit CNT is configured to con-

trol the operation of the first to sixth MOSFETs Tr1 to Tr6, by outputting the gate control signal (the gate voltage) to the gates of the first to sixth MOSFETs Tr1 to Tr6 of the driver circuit D.

[0051] Then, in particular, the control unit CNT drives the internal combustion engine by controlling the driver circuit D to drive the motor generator G, based on the voltage VT3 output from the vehicle power supply control circuit 100.

[0052] Also, the vehicle power supply control circuit 100 is mounted on a two-wheeled vehicle equipped with an internal combustion engine, as described above.

[0053] Here, for example, as shown in FIGS. 1 and 2, the vehicle power supply control circuit 100 comprises a first input terminal T1, a second input terminal T2, an output terminal T3, a switch circuit Y, a switch controller X, and a protection resistor R400.

[0054] The first input terminal T1 is electrically connected to the output of the DC-DC converter 20, as shown in FIG. 1, for example.

[0055] The first input terminal T1 is supplied with the voltage (eg, boosted voltage) output from the DC-DC converter that voltage-converts (for example, boosts or boosts or lowers) the power supply voltage VT2 supplied from the battery B or the motor generator G via the main switch SW and the terminal TA.

[0056] The second input terminal T2 is electrically connected to the input of the DC-DC converter 20 via a connection terminal TA, as shown in FIG. 1, for example.

[0057] The power supply voltage VT2 is supplied to the second input terminal T2.

[0058] Further, the output terminal T3 outputs a voltage for controlling the semiconductor elements (first to sixth MOSFETs Tr1 to Tr6) that generate a drive current of ACG (motor generator) G and has an unsaturated region characteristic.

[0059] Further, for example, as shown in FIG. 2, the protection resistor R400 has one end connected to the output terminal T3, and has the other end connected to the ground terminal N (the ground potential which is a fixed potential).

[0060] Further, for example, as shown in FIG. 2, the switch circuit Y has one end connected to the first input terminal T1, has the other end connected to the output terminal T3, and has a control terminal TC.

[0061] For example, when the switch circuit Y is turned on based on the signal applied to the control terminal TC, the first input terminal T1 and the output terminal T3 are electrically connected.

[0062] On the other hand, the switch circuit Y is adapted to cut off between the first input terminal T1 and the output terminal T3 by turning off based on the signal applied to the control terminal TC.

[0063] For example, as shown in FIG. 2, the switch circuit Y includes a switch bipolar transistor Q400, a first switch resistor R401, and a second switch resistor R402.

[0064] The emitter of the switch bipolar transistor Q400 is connected to the first input terminal T1, and the collec-

tor of the switch bipolar transistor Q400 is connected to the output terminal T3.

[0065] As described later, this switch bipolar transistor Q400 has a threshold value set to turn on the switch bipolar transistor Q400 when the first bipolar transistor Q401 turns on or the second bipolar transistor Q402 turns on.

[0066] Further, the first switch resistor R401 has one end connected to the base of the switch bipolar transistor Q400, and has the other end connected to the control terminal TC.

[0067] The second switch resistor R402 has one end connected to the emitter of the switch bipolar transistor Q400, and has the other end connected to the base of the switch bipolar transistor Q400.

[0068] Also, the switch controller X controls the switch circuit Y by applying a signal to the control terminal TC based on the voltage of the second input terminal T2.

[0069] For example, the switch controller X turns on the switch circuit Y, when the power supply voltage VT2 supplied to the second input terminal T2 rises and becomes equal to or higher than the preset first threshold voltage with the switch circuit Y turned off. After that, the switch controller X turns off the switch circuit Y, when the power supply voltage VT2 supplied to the second input terminal T2 becomes lower than the second threshold voltage different from the first threshold voltage (the second threshold voltage is higher than the first threshold voltage or lower than the first threshold voltage), after the power supply voltage VT2 further rises.

[0070] For example, as shown in FIG. 2, the switch controller X comprises a first control circuit X1, a second control circuit X2, and a third control circuit X3.

[0071] Then, the first control circuit X1 controls the switch circuit Y based on the power supply voltage VT2 supplied to the second input terminal T2.

[0072] For example, the first control circuit X1 is configured to turn on the switch circuit Y, when the power supply voltage VT2 becomes equal to or higher than the first threshold voltage.

[0073] On the other hand, the first control circuit X1 operates so as to turn off the switch circuit Y, when the power supply voltage VT2 becomes lower than the above-mentioned first threshold voltage.

[0074] For example, as shown in FIG. 2, the first control circuit X1 has a first bipolar transistor Q401, a first resistor R403, a first diode D400, and a second resistor R404.

[0075] The first bipolar transistor Q401 is a first conductivity type (NPN type) bipolar transistor, a collector of the first bipolar transistor Q401 is connected to the control terminal TC, and an emitter of the collector of the first bipolar transistor Q401 is connected to the ground terminal N (ground potential which is a fixed potential).

[0076] The threshold value of the first bipolar transistor Q401 is set to turn on the first bipolar transistor Q401, for example, when the power supply voltage VT2 initially rises, by passing the base current through the path from the first resistor R403 to the first diode D400.

[0077] Moreover, one end of the first resistor R403 is connected to the second input terminal T2.

[0078] The anode of the first diode D400 is connected to the first resistor R403, and the cathode of the first diode D400 is connected to the base of the first bipolar transistor Q401.

[0079] Further, the second resistor R404 has one end connected to the base of the first bipolar transistor Q401, and has the other end connected to the ground terminal N (the ground potential which is a fixed potential).

[0080] Also, the second control circuit X2 controls the switch circuit Y, based on the power supply voltage VT2 supplied to the second input terminal T2.

[0081] For example, the second control circuit X2 turns on the switch circuit Y when the power supply voltage VT2 becomes equal to or higher than the above-mentioned second threshold voltage.

[0082] On the other hand, the second control circuit X2 operates to turn off the switch circuit Y, when the power supply voltage VT2 becomes lower than the second threshold voltage.

[0083] For example, as shown in FIG. 2, the second control circuit X2 comprises a second bipolar transistor Q402, a first Zener diode Z400, a third resistor R405, and a fourth resistor R406.

[0084] The second bipolar transistor Q402 is a first conductivity type (NPN type) bipolar transistor, a collector of the second bipolar transistor Q402 is connected to the control terminal TC, and an emitter of the second bipolar transistor Q402 is connected to the ground terminal N (the ground potential which is a fixed potential).

[0085] The threshold value of the second bipolar transistor Q402 is set to turn on the second bipolar transistor Q402, by passing the base current from the first Zener diode Z400 through the path of the third resistor R405, if the power supply voltage VT2 rises further than a voltage when the power supply voltage VT2 initially rises.

[0086] The cathode of the first Zener diode Z400 is connected to the second input terminal T2.

[0087] Also, the third resistor R405 has one end connected to the anode of the first Zener diode Z400, and has the other end connected to the base of the second bipolar transistor Q402.

[0088] Also, the fourth resistor R406 has one end connected to the base of the second bipolar transistor Q402, and has the other end connected to the emitter of the second bipolar transistor Q402.

[0089] Also, the third control circuit X3 is configured to control the operation of the first control circuit X1, based on the power supply voltage VT2 supplied to the second input terminal T2.

[0090] For example, the third control circuit X3 controls the first control circuit X1 to avoid the switch circuit Y being turned on by the first control circuit X1, when the power supply voltage VT2 becomes equal to or higher than a preset third threshold voltage higher than the above-mentioned second threshold voltage.

[0091] The third control circuit X3 comprises, for ex-

ample, as shown in FIG. 2, a second Zener diode Z401, a fifth resistor R407, a sixth resistor R408, a third bipolar transistor Q403, a fourth bipolar transistor Q404, and a capacitor C400.

[0092] The cathode of the second Zener diode Z401 is connected to the second input terminal T2.

[0093] Also, the fifth resistor R407 has one end connected to the anode of the second Zener diode Z401.

[0094] Further, the sixth resistor R408 has one end connected to the other end of the fifth resistor R407, and has the other end connected to the ground terminal N (the ground potential which is a fixed potential).

[0095] The third bipolar transistor Q403 is a first-conductivity-type (NPN-type) bipolar transistor, an emitter of the third bipolar transistor Q403 is connected to the other end of the sixth resistor R408, and a base of the third bipolar transistor Q403 is connected to one end of the sixth resistor R408.

[0096] The fourth bipolar transistor Q404 is a second conductivity type (PNP type) bipolar transistor, an emitter of the fourth bipolar transistor Q404 is connected to the anode of the first diode D400 (the other end of the first resistor R403), a collector of the fourth bipolar transistor Q404 is connected to the base of the third bipolar transistor Q403, and a base of the fourth bipolar transistor Q404 is connected to the collector of the third bipolar transistor Q403.

[0097] The capacitor C400 has one end connected to the emitter of the fourth bipolar transistor Q404, and has the other end connected to the emitter of the third bipolar transistor Q403.

[0098] Next, an example of a control method of the vehicle power supply control circuit 100 having the above configuration will be described.

[0099] For example, the switch control unit X turns on the switch circuit Y, when the power supply voltage VT2, supplied to the second input terminal T2, rises and becomes equal to or higher than a preset first threshold voltage.

[0100] More specifically, when the power supply voltage VT2 rises (when the power supply voltage VT2 becomes equal to or higher than the first threshold voltage), the switch control unit X turns on the switch bipolar transistor Q400 by the first control circuit X1, by passing the base current through the path from the first resistor R403 to the first diode D400 to turn on the first bipolar transistor Q401, to perform the first input terminal T1 and the output terminal T3 are electrically connected.

[0101] That is, when the power supply voltage VT2 rises, the switch control unit X turns on the switch circuit Y, when the power supply voltage VT2 is in a low level.

[0102] Then, after the power supply voltage VT2 further rises, the switch control circuit Y turns off the switch circuit Y, when the power supply voltage VT2 supplied to the second input terminal T2 becomes less than the second threshold voltage different from the first threshold voltage (Here, the second threshold voltage is higher than the first threshold voltage).

[0103] More specifically, when the power supply voltage VT2 further rises, the base current is supplied from the first Zener diode Z400 to the path of the third resistor R405, the switch control unit Y turns on the switch bipolar transistor Q400 by the second control circuit X2, by turning on the second bipolar transistor Q402. After the switch control unit Y turns on the switch bipolar transistor Q400 by the second control circuit X2 as described above, and then, the power supply voltage VT2 further rises (Here, the voltage rises above the second threshold, which is higher than the first threshold voltage), and the base current flows through the path from the second Zener diode Z401 to the fifth resistor R407, thereby the switch control unit Y turns off the first bipolar transistor Q401 by turning on the third bipolar transistor Q403 and the fourth bipolar transistor Q404.

[0104] Here, the switch control unit X turns off the first bipolar transistor Q401 as described above, and then, the switch control unit X turns off the second bipolar transistor Q402 to turn off the switch bipolar transistor Q400 by the second control circuit X2, when the power supply voltage VT2 drops below the above-mentioned second threshold voltage from the state in which the second to fourth bipolar transistors Q402, Q403 and Q404 are on. As a result, the connection between the first input terminal T1 and the output terminal T3 is cut off.

[0105] That is, the switch control circuit Y turns off the switch circuit Y, when the power supply voltage VT2 is higher than the first threshold voltage which is less than the second threshold voltage, after the power supply voltage VT2 rises above the second threshold voltage.

[0106] Here, as described above, the output voltage output from the DC-DC converter 20 may be held for some time after the supply of the power supply voltage VT2 to the DC-DC converter 20 is cut off by turning off the main switch SW by a user operation.

[0107] In such a case, between the output of the DC-DC converter 20 and the output terminal T3, that outputs a voltage for driving the semiconductor devices (MOSFETs) Tr1 to Tr6 generate drive current for the motor generator G and have unsaturated region characteristics, can be quickly cut off by the operation of the vehicle power supply control circuit 100 as described above.

[0108] As a result, until the output voltage of the DC-DC converter 20 is stopped, this output voltage is suppressed from being applied to the gates of the semiconductor elements (MOSFETs) Tr1 to Tr6 that form the driver circuit D that controls the motor generator G, and the semiconductor element can be suppressed from operating in the unsaturated region.

[0109] That is, according to the vehicle power supply control circuit 100 of the present invention, the unsaturated operation of the semiconductor element can be prevented by controlling conduction/interruption between the output of the DC-DC converter for converting the power supply voltage VT2 into a voltage and the output terminal for outputting a voltage for driving the semiconductor element that generates drive current for motor gen-

erator G and has unsaturated region characteristics, based on the power supply voltage VT2.

[Second Embodiment]

[0110] In the above-described first embodiment, as shown in FIG. 2, the third control circuit X3 comprises the second Zener diode Z401, the fifth resistor R407, the sixth resistor R408, the third bipolar transistor Q403, the fourth bipolar transistor Q404, and the capacitor C400.

[0111] However, the circuit configured by the third bipolar transistor Q403 and the fourth bipolar transistor Q404 may have another circuit configuration as long as it performs the same operation.

[0112] For example, the circuit composed of the third bipolar transistor Q403 and the fourth bipolar transistor Q404 may be replaced with a circuit structure using a semiconductor element such as a thyristor.

[0113] A vehicle power supply control circuit according to an embodiment according to an aspect of the present invention includes: a first input terminal T1 to which a voltage output from an DC-DC converter 20 converting a power supply voltage VT2 is supplied; a second input terminal T2 to which the power supply voltage is supplied; an output terminal T3 to output a voltage for controlling semiconductor elements (MOSFET (Tr)) generating a drive current for a motor generator and having unsaturated region characteristics; a switch circuit having one end connected to the first input terminal and the other end connected to the output terminal, the switch circuit is turned on based on a signal applied to a control terminal TC thereof to establish electrical connection between the first input terminal and the output terminal, on the other hand, the switch circuit is turned off based on a signal applied to the control terminal to cuts off between the first input terminal and the output terminal; and a switch controller that controls the switch circuit by applying a signal to the control terminal based on the voltage of the second input terminal. The switch controller turns on the switch circuit, when the power supply voltage supplied to the second input terminal rises and becomes equal to or higher than a preset first threshold voltage while the switch circuit is off, and after that, after the power supply voltage VT2 further rise, the switch controller turns off the switch circuit, when the power supply voltage VT2 supplied to the second input terminal becomes less than a second threshold voltage different from the first threshold voltage.

[0114] That is, according to the vehicle power supply control circuit of the present invention, the unsaturated operation of the semiconductor element can be prevented by controlling conduction/interruption between the output of the DC-DC converter for converting the power supply voltage VT2 into a voltage and the output terminal for outputting a voltage for driving the semiconductor element that generates drive current for the ACG and has unsaturated region characteristics, based on the power supply voltage.

[0115] While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. The embodiments may be embodied in a variety of other forms. Furthermore, various omissions, substitutions and changes in the form of the methods and systems described herein may be made without departing from the spirit of the inventions. The embodiments and their modifications are included in the scope and the subject matter of the invention, and at the same time included in the scope of the claimed inventions and their equivalents.

[Explanation of References]

[0116]

1000	Vehicle control unit (ECU)
100	Vehicle power supply control circuit
20	DC-DC converter
D25	Diode
CNT	Control unit (control IC)
D	Driver circuit
B	Battery
T1	First input terminal
T2	Second input terminal
T3	Output terminal
Y	Switch circuit
X	Switch controller
R400	Protection resistor
X1	First control circuit
X2	Second control circuit
X3	Third control circuit
Q401	First bipolar transistor
R403	First resistor
D400	First diode
R404	Second resistance
Q402	Second bipolar transistor
Z400	First Zener diode
R405	Third resistance
R406	Fourth resistance
Z401	Second Zener diode
R407	Fifth resistance
R408	Sixth resistance
Q403	Third bipolar transistor
Q404	Fourth bipolar transistor
C400	Capacitor

Claims

1. A vehicle power supply control circuit, comprising:
 - a first input terminal to which a voltage output from an DC-DC converter converting a power supply voltage is supplied;
 - a second input terminal to which the power supply voltage is supplied;

an output terminal to output a voltage for controlling semiconductor elements generating a drive current for a motor generator and having unsaturated region characteristics;

a switch circuit having one end connected to the first input terminal and the other end connected to the output terminal, the switch circuit is turned on based on a signal applied to a control terminal thereof to establish electrical connection between the first input terminal and the output terminal, on the other hand, the switch circuit is turned off based on a signal applied to the control terminal to cuts off between the first input terminal and the output terminal; and
a switch controller that controls the switch circuit by applying a signal to the control terminal based on the voltage of the second input terminal, wherein

the switch controller turns on the switch circuit, when the power supply voltage supplied to the second input terminal rises and becomes equal to or higher than a preset first threshold voltage while the switch circuit is off, and
after that, after the power supply voltage further rise, the switch controller turns off the switch circuit, when the power supply voltage supplied to the second input terminal becomes less than a second threshold voltage different from the first threshold voltage.

2. The vehicle power supply control circuit according to claim 1, wherein the semiconductor element is a MOSFET, and the voltage for controlling the semiconductor element is a gate voltage of the MOSFET.
3. The power supply control circuit for a vehicle according to claim 2, wherein the switch controller comprises:

a first control circuit that operates to turn on the switch circuit when the power supply voltage becomes equal to or higher than the first threshold voltage, and the first control circuit operates to turn off the switch circuit when the power supply voltage becomes lower than the first threshold voltage;

a second control circuit that operates to turn on the switch circuit when the power supply voltage becomes equal to or higher than the second threshold voltage, and the second control circuit operates to turn off the switch circuit when the power supply voltage becomes lower than the second threshold voltage;

a third control circuit that controls the operation of the first control circuit based on the power supply voltage supplied to the second input terminal, wherein the third control circuit controls the first

control circuit to prevents the switch circuit from being turned on by the first control circuit, when the power supply voltage is equal to or higher than a preset third threshold voltage which is higher than the second threshold voltage.

4. The vehicle power supply control circuit according to claim 3, wherein the first control circuit includes:

a first bipolar transistor being a first conductivity type bipolar transistor, having a collector connected to the control terminal, and having an emitter connected to a fixed potential;
a first resistor having one end connected to the second input terminal;
a first diode having an anode connected to the first resistor, and having a cathode connected to a base of the first bipolar transistor; and
a second resistor having one end connected to a base of the first bipolar transistor, and having the other end connected to the fixed potential.

5. The vehicle power supply control circuit according to claim 4, wherein the second control circuit includes:

a second bipolar transistor being a first conductivity type bipolar transistor, having a collector connected to the control terminal, and having an emitter is connected to the fixed potential;
a first Zener diode having a cathode connected to the second input terminal;
a third resistor having one end connected to the anode of the first Zener diode, and having the other end connected to a base of the second bipolar transistor; and
a fourth resistor having one end connected to the base of the second bipolar transistor, and having the other end connected to the emitter of the second bipolar transistor.

6. The vehicle power supply control circuit according to claim 5, wherein the third control circuit includes:

a second Zener diode having a cathode connected to the second input terminal;
a fifth resistor having one end connected to an anode of the second Zener diode;
a sixth resistor having one end connected to the other end of the fifth resistor, and having the other end connected to the fixed potential;
a third bipolar transistor being a first conductivity type bipolar transistor, having an emitter connected to the other end of the sixth resistor, and having a base connected to one end of the sixth resistor;
a fourth bipolar transistor being a second conductivity type bipolar transistor having an emitter

- connected to the anode of the first diode, having a collector connected to the base of the third bipolar transistor, and having a base connected to a collector of the third bipolar transistor; and a capacitor having one end connected to the emitter of the fourth bipolar transistor, and having the other end connected to the emitter of the third bipolar transistor.
7. The vehicle power supply control circuit according to claim 6, wherein the switch circuit includes:
- a switch bipolar transistor having an emitter connected to the first input terminal, and having a collector connected to the output terminal;
- a first switch resistor having one end connected to a base of the switch bipolar transistor, and having the other end connected to the control terminal; and
- a second switch resistor having one end connected to the emitter of the switch bipolar transistor, and having the other end connected to the base of the switch bipolar transistor.
8. The vehicle power supply control circuit according to claim 7,
- wherein,
- when the power supply voltage initially rises, the switch controller turns on the switch bipolar transistor by the first control circuit to establish conduction between the first input terminal and the output terminal, by turning on the first bipolar transistor by passing a base current through a path from the first resistor to the first diode,
- then, when the power supply voltage further rises, the switch controller turns on the switch bipolar transistor by the second control circuit, by turning on the second bipolar transistor by passing a base current through a path from the first Zener diode to the third resistor, and
- then, when the power supply voltage further rises, the switch controller turns off the switch bipolar transistor, by turning on the third bipolar transistor and the fourth bipolar transistor by passing a base current through a path from the second Zener diode to the fifth resistor.
9. The vehicle power supply control circuit according to claim 7, wherein, when the power supply voltage drops below the second threshold voltage from the state in which the second to fourth bipolar transistors are turned on after turning off the first bipolar transistor, the switch controller turns off the switch bipolar transistor by the second control circuit, by turning off the second bipolar transistor, to disconnect between the first input terminal and the output terminal.
10. The vehicle power supply control circuit according
- to claim 2, wherein the voltage output from the output terminal is supplied to a control unit that drives the semiconductor element via a diode.
11. The vehicle power supply control circuit according to claim 2, further comprising a protection resistor having one end connected to the output terminal and the other end connected to a fixed potential.
12. The vehicle power supply control circuit according to claim 2,
- wherein the first input terminal is electrically connected to an output of the DC-DC converter,
- wherein the second input terminal is electrically connected to an input of the DC-DC converter, and
- wherein the DC-DC converter includes a smoothing capacitor connected to the output of the DC-DC converter.
13. The vehicle power supply control circuit according to claim 2,
- wherein the vehicle power supply control circuit is mounted on a motorcycle,
- wherein the MOSFET constitutes a driver circuit of the motor generator connected to an internal combustion engine of the motorcycle,
- wherein the control IC drives the internal combustion engine by driving the motor generator with the driver circuit based on a voltage output from the vehicle power supply control circuit, and
- wherein a battery mounted on the motorcycle is connected between the power supply terminal to which the power supply voltage is applied and the fixed potential.
14. The vehicle power supply control circuit according to claim 13, wherein the supply of the power supply voltage is controlled by a main switch of the two-wheeled vehicle operated by a user.
15. The vehicle power supply control circuit according to claim 7,
- wherein a threshold value of the first bipolar transistor is set to turn on the first bipolar transistor, when the power supply voltage initially rises, by passing the base current through the path from the first resistor to the first diode,
- wherein a threshold value of the second bipolar transistor is set to turn on the second bipolar transistor, by passing the base current from the first Zener diode through the path of the third resistor, if the power supply voltage rises further than a voltage when the power supply voltage initially rises, and
- wherein a threshold value of the switch bipolar transistor is set to turn on the switch bipolar transistor, when the first bipolar transistor is turned on or the second bipolar transistor is turned on.

16. A vehicle control device, comprising:

a DC-DC converter that converts a power supply voltage into a voltage;
 a vehicle power supply control circuit to which the voltage output from the DC-DC converter is supplied;
 a driver circuit that includes a semiconductor element, the semiconductor element generating a drive current for a motor generator and having unsaturated region characteristics, and
 a control unit that controls the driver circuit based on a voltage output from the vehicle power supply control circuit,
 wherein the vehicle power supply control circuit comprises:

a first input terminal to which a voltage output from the DC-DC converter is supplied;
 a second input terminal to which the power supply voltage is supplied;
 an output terminal to output a voltage for controlling semiconductor elements generating a drive current for a motor generator and having unsaturated region characteristics;
 a switch circuit having one end connected to the first input terminal and the other end connected to the output terminal, the switch circuit is turned on based on a signal applied to a control terminal thereof to establish electrical connection between the first input terminal and the output terminal, on the other hand, the switch circuit is turned off based on a signal applied to the control terminal to cuts off between the first input terminal and the output terminal; and
 a switch controller that controls the switch circuit by applying a signal to the control terminal based on the voltage of the second input terminal,
 wherein
 the switch controller turns on the switch circuit, when the power supply voltage supplied to the second input terminal rises and becomes equal to or higher than a preset first threshold voltage while the switch circuit is off, and
 after that, after the power supply voltage further rise, the switch controller turns off the switch circuit, when the power supply voltage supplied to the second input terminal becomes less than a second threshold voltage different from the first threshold voltage.

17. A vehicle power supply control circuit control method of vehicle power supply control circuit, the vehicle power supply control circuit comprising: a first input

terminal to which a voltage output from an DC-DC converter converting a power supply voltage is supplied; a second input terminal to which the power supply voltage is supplied; an output terminal to output a voltage for controlling semiconductor elements generating a drive current for a motor generator and having unsaturated region characteristics; a switch circuit having one end connected to the first input terminal and the other end connected to the output terminal, the switch circuit is turned on based on a signal applied to a control terminal thereof to establish electrical connection between the first input terminal and the output terminal, on the other hand, the switch circuit is turned off based on a signal applied to the control terminal to cuts off between the first input terminal and the output terminal; and a switch controller that controls the switch circuit by applying a signal to the control terminal based on the voltage of the second input terminal,

wherein
 the switch controller turns on the switch circuit, when the power supply voltage supplied to the second input terminal rises and becomes equal to or higher than a preset first threshold voltage while the switch circuit is off, and
 after that, after the power supply voltage further rise, the switch controller turns off the switch circuit, when the power supply voltage supplied to the second input terminal becomes less than a second threshold voltage different from the first threshold voltage.

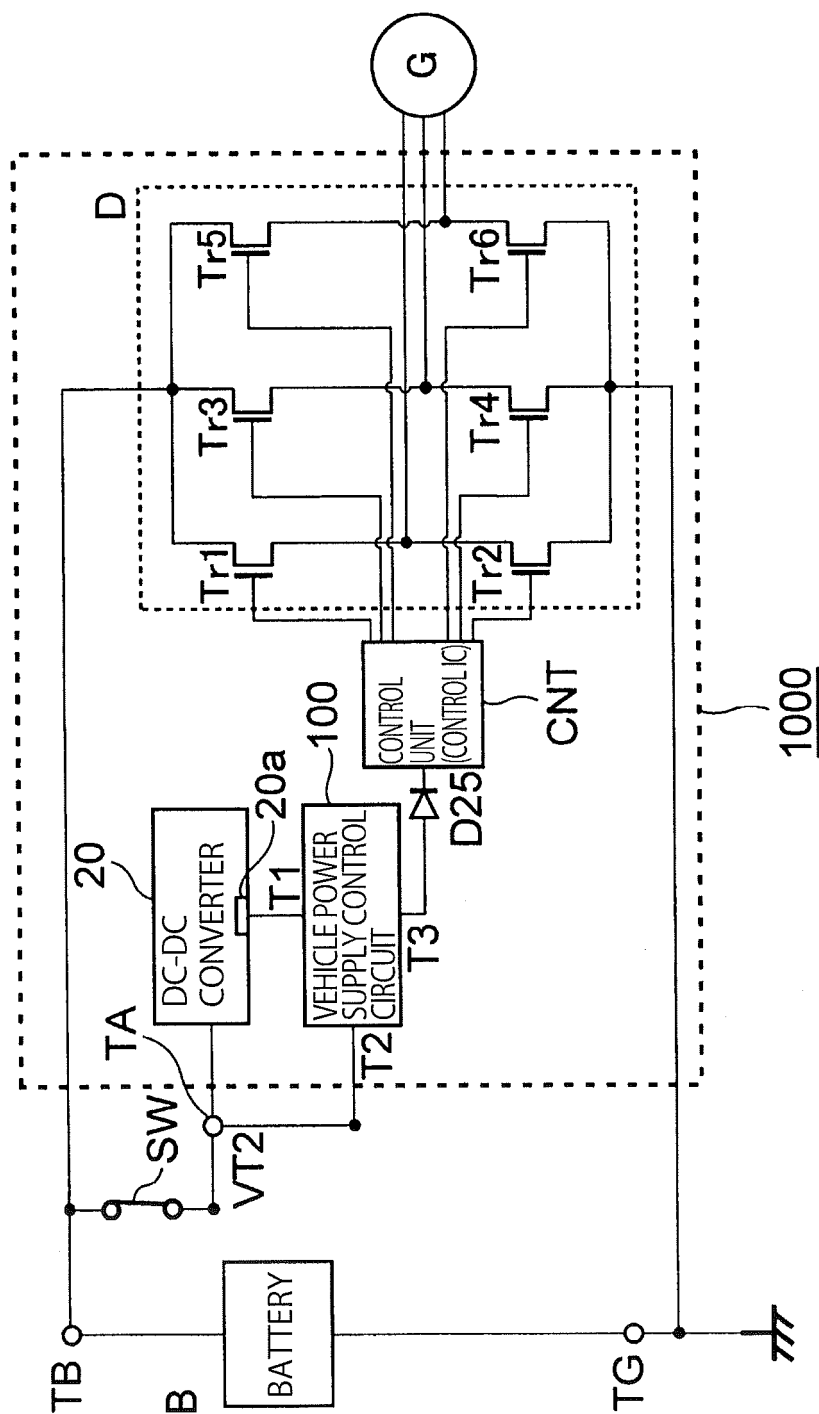


FIG. 1

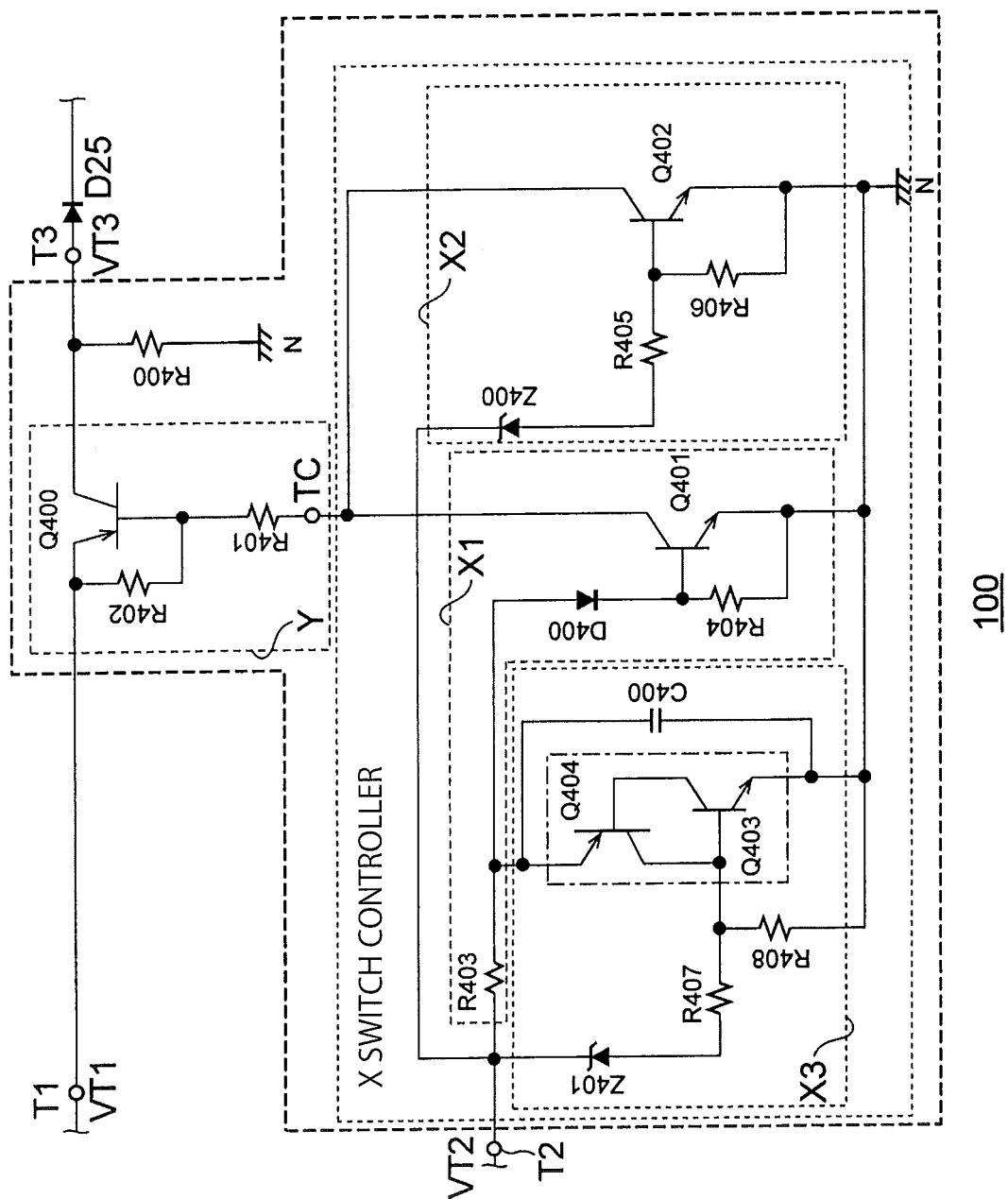


FIG. 2

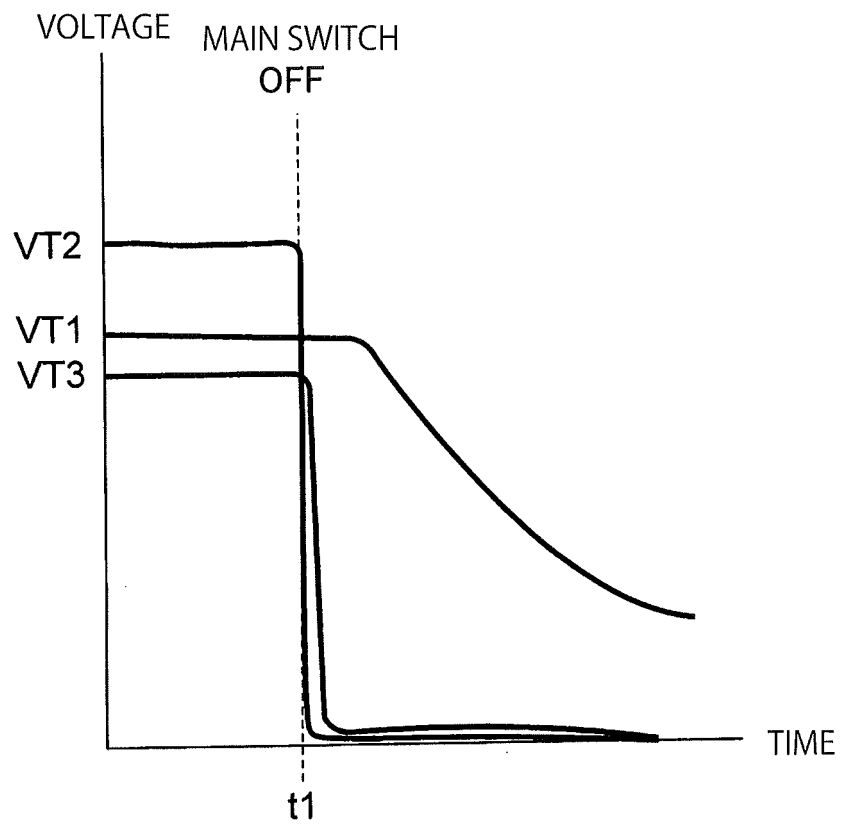


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2018/000976

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. H02M1/08 (2006.01) i, H02M3/00 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. H02M1/08, H02M3/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2018

Registered utility model specifications of Japan 1996-2018

Published registered utility model applications of Japan 1994-2018

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2-202117 A (KANSAI NIPPON ELECTRIC) 10 August 1990, entire text, all drawings (Family: none)	1-17
A	JP 2014-86953 A (ROHM CO., LTD.) 12 May 2014, entire text, all drawings & US 2014/0117891 A1, entire text, all drawings	1-17
A	JP 2004-526397 A (ROBERT BOSCH GMBH) 26 August 2004, entire text, all drawings & WO 2002/082625 A2, entire text, all drawings & EP 1378048 A2	1-17



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

27.03.2018

Date of mailing of the international search report

03.04.2018

Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2202117 A [0006]